PROSPECTIVE ANALYTICAL STUDY OF PATTERN OF INJURIES IN FATAL CASES OF ACCIDENTAL FALL- AUTOPSY CONDUCTED AT MADURAI MEDICAL COLLEGE

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CERTIFICATE

This is to certify that the dissertation entitled **"PROSPECTIVE ANALYTICAL STUDY OF PATTERN OF INJURIES IN FATAL CASES OF ACCIDENTAL FALL-AUTOPSY CONDUCTED AT MADURAI MEDICAL COLLEGE"** is the bonafide work of **Dr. R.UTHAYAKUMAR** in partial fulfillment of the university regulations of the Tamilnadu Dr. M.G.R. Medical University, Chennai, for M.D., (Forensic Medicine) Branch–14 examination to be held in May 2018.

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DECLARATION

I, **Dr. R.UTHAYAKUMAR**, hereby declare that, I carried out this work on **"PROSPECTIVE ANALYTICAL STUDY OF PATTERN OF INJURIES IN FATAL CASES OF ACCIDENTAL FALL-AUTOPSY CONDUCTED AT MADURAI MEDICAL COLLEGE."** at the Department of Forensic Medicine, Government Rajaji Hospital, Madurai, under the guidance of **Prof. Dr. T. SELVARAJ, M.D. D.C.H.,** Head of the Department of Forensic Medicine, during the period of one year from January 2016 to December 2016. I also declare that this bona fide work has not been submitted in part or full by me or any others for any award, degree or diploma to any other University or Board either in India or Abroad.

This is submitted to the Tamilnadu Dr.M.G.R.Medical University, Chennai in partial fulfilment of the rules and regulations for the M.D. Degree Examination in Forensic Medicine (Branch –18) to be held in May-2018 .

Dr.R.UTHAYAKUMAR

Place : Madurai

Date :

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CONTENTS

INTRODUCTION

Accident is an occurrence in a sequence of events that produces unintended injury, death or property damage and it is an unpremeditated event that results in recognizable damage.

Deaths due to accidental fall, form an important area of study due to diversity of the injuries sustained, complexity of the patterns involved and various phenomenon's associated there with.

The medico-legal autopsy aims at deciding whether the death was attribute purely to the accidental fall. It also helps in ruling out the various contributing factors like drugs, alcohol and co-existing natural disease.

A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level.

Falls are the second leading cause of unintentional injury mortality and they account for 11%of all unintentional injury deaths worldwide. According to the World Health Organization WHO), about 424 000 fall-related deaths occurred globally in 2004 and about one fifth of them (95000 deaths) took place in India.

The National Crime and Records Bureau (NCRB), which is the only agency that collects national injury data in India, reported that in 2005 falls contributed 3.2% of all unintentional injury deaths in the country. This figure reflects the large underreporting well known to exist in police-based

reports. Two surveys are additional national sources of cause specific mortality in India: the Medically Certified Causes of Death (MCCD) survey and the Survey of Cause of Death (SCD), last conducted in 1998.

The MCCD survey reports on causes of death based on mortality data from urban hospitals. According to this survey, falls were the cause of 2% of all unintentional injury deaths registered in 2004.

In the SCD, the sample units are primary health-care centres in selected rural health facilities and an algorithm is used to determine the causes of death in the population. According to the SCD, fall-related deaths comprised 8% of all unintentional injury deaths in rural areas in India in1998.The MCCD and SCD are not representative of India's urban and rural populations.

Furthermore, these surveys and the NCRB have shortcomings, namely low population coverage, the use of different data sources and a high proportion of deaths that are either misclassified or attributed to ill-defined causes.

Falls accounted for 25% (2003/8023) of all deaths from unintentional injury and were the second leading cause of such deaths. An estimated160 000 fall-related deaths occurred in India in 2005; of these, nearly 20 000 were in children aged 0–14 years. The unintentional-fall-related mortality rate (MR) per100 000 population was 14.5 (99%

confidence interval, CI: 13.7–15.4). Rates were similar for males and females at 14.9 (99% CI: 13.1–15.3) and 14.2 (99% CI: 13.1–15.5) per 100 000 population, respectively. People aged 70 years or older had the highest mortality rate from unintentional falls (MR: 271.2; 99%CI: 249.0–293.5), and the rate was higher among women (MR: 281; 99% CI: 258.3–302.5).

Falls on the same level were the most common among older adults, whereas falls from heights were more common in younger age groups.

Fall related deaths ranked as the twelfth leading cause of death among 5 to 9 years old.

Older people frequently fall. This is a serious public health problem, with a Substantial impact on health and healthcare costs. Falls are one of the most Common geriatric syndromes threatening the independence of older persons.

They are the leading cause of injury deaths and disabilities among persons aged >65 years .Unintentional falls are one of the most costly and complex health issues facing older persons in the world. Fall-related injuries are more common among older persons and are a major cause of pain, disability, loss of independence and premature death. Injuries are the sixth leading cause of death in adults of 65 years of age or more and falls are the leading cause of such injuries.

In fact, falls account for approximately 10% of visits to emergency department and 6% of urgent hospitalization among elderly people. Elder people constitute about 6.9 % of population in India and with increase in life expectancy, it is expected that the number will increase further. The substantial increase of elder population will expand a potential group of individuals who are vulnerable to falls and likely to be victims of its consequences. Review of Indian literature reveals that only few epidemiological study on fall induced injuries and deaths of elder adults has been conducted. The purpose of present study is to assess the trends and circumstances of fall-induced deaths in varies age group people and to provide epidemiological data so that preventive measures can be undertaken.

In developing countries noticed deaths due to accidental fall is increasing yearly as the many work activities involve working at height.

Many workers in maintenance, construction and many other people in a variety of jobs could be at risk of accidental fall, examples include painters, decorators, window cleaners and those who undertake one off jobs without proper training, planning or equipment.

Falls in children tend to be from balconies, windows, and trees, and most frequently tend to occur in homes, followed by schoolyards and playgrounds.

Falls result from a complex and interactive mix of biological or medical, behavioral and environmental factors, many of which are amenable to intervention.

Fall-accidents represents unintentional form of injuries and are leading cause of morbidity and mortality in elder population.

There is a growing body of international evidence of best-practices for the prevention of falls and fall-related injuries. An ever growing number of falls prevention interventions are being implemented.

AIM AND OBJECTIVES OF THE STUDY

1. To study the age and sex distribution, place, surface, time ,and outcome of fatal accidental fall.
2. To conduct a study of the pattern of injuries sustained to the victim in different types of impact.
3. To correlate detailed about the pattern of injuries with varies level of accidental fall. (ground level fall, fall from height)
4. To draw conclusions regarding the cause of death
5. To make preventive strategy and effective policies to reduce and avoid the accidental fall.

REVIEW OF LITERATURE

FORENSIC ASPECT OF ACCIDENTAL FALL

Definition of a fall

The actual definition of a fall in older people has been open to some debate. A frequently used definition is "unintentionally coming to the ground or some lower level and other than as a consequence of sustaining violent blow, loss of consciousness, sudden onset of paralysis as in stroke or an epileptic seizure. This definition excludes overwhelming external disturbances that result in an older person being knocked over, and major internal disturbances that cause an older person to collapse instead of fall. Some researchers use a broader definition of falls to include those that occur because of dizziness and syncope .

A fall is also defined as a sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor, or the ground, as a consequence of sudden onset of paralysis, epileptic seizure, or overwhelming external force.

A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level.

On the basis of manner of death fall into:

1. Accidental fall
2. Suicidal fall
3. Homicidal fall

Accidental fall :

Unintentionally dropping onto the ground or lower level not as a result of a major intrinsic event (such as a stroke) or overwhelming hazard.

Types of Accidental Fall :

Accidental Fall can be classified into

Depending on the height of fall

- Low level falls (Ground level fall)
- High level falls (Fall from height)

LOW LEVEL FALL:

It includes 1)Ground Level Fall generally slips or trips. Injury results when the individual hits a walking or working surface or strikes

some other object during the fall.2),Fall from short distance such as sofa, bed, chair or table under 1.5 meter of height.

- Low-Level Falls (Ground Level Fall): high frequency--low severity.

High level fall :

Fall from more than 1.5 meter of height.

- High Level Fall (Fall from Height): lower frequency--high severity.

Cause of Fall Codes – ICD-9 and ICD-10

The following information has been excerpted from the International Classification of Diseases – versions 9 and 10 These are the sections that relate to causes of fall injuries.

ICD-9 Codes for Causes of Fall Injuries

ACCIDENTAL FALLS (E880-E888)

Excludes: falls (in or from):

burning building (E890.8, E891.8)
into fire (E890.0-E899)
into water (with submersion or drowning) (E910.0-E910.9)
machinery (in operation) (E919.0-E919.9)
on edged, pointed, or sharp object (E920.0-E920.9)
transport vehicle (E800.0-E845.9)
vehicle not elsewhere classifiable (E846-E848)

E880 Fall on or from stairs or steps

E880.0 Escalator

E880.1 Fall on or from sidewalk curb

Excludes: fall from moving sidewalk (E885.9)

E880.9 Other stairs or steps

E881 Fall on or from ladders or scaffolding

E881.0 Fall from ladder

E881.1 Fall from scaffolding

E882 Fall from or out of building or other structure

Fall from:

balcony

bridge

building

flagpole

tower

turret

viaduct

wall

window

Fall through roof

Excludes: collapse of a building or structure (E916)

fall or jump from burning building (E890.8, E891.8)

E883 Fall into hole or other opening in surface.

Includes: fall into:

cavity

dock

hole

pit

quarry

shaft

swimming pool

tank

well

Excludes: fall into water NOS (E910.9)

that resulting in drowning or submersion without mention of injury (E910.0-E910.9)

E883.0 Accident from diving or jumping into water [swimming pool]

Strike or hit:

against bottom when jumping or diving into water

wall or board of swimming pool

water surface

Excludes: diving with insufficient air supply (E913.2)

effects of air pressure from diving (E902.2)

E883.1 Accidental fall into well

E883.2 Accidental fall into storm drain or manhole

E883.9 Fall into other hole or other opening in surface

E884 Other fall from one level to another

E884.0 Fall from playground equipment

Excludes: recreational machinery (E919.8)

E884.1 Fall from cliff

E884.2 Fall from chair

E884.3 Fall from wheelchair

E884.4 Fall from bed

E884.5 Fall from other furniture

E884.6 Fall from commode
Toilet

E884.9 Other fall from one level to another
Fall from:
Embankment
haystack
stationary vehicle
tree

E885 Fall on same level from slipping, tripping, or stumbling

E885.0 Fall from (nonmotorized) scooter

E885.1 Fall from roller skates

In-line skates

E885.2 Fall from skateboard

E885.3 Fall from skis

E885.4 Fall from snowboard

E885.9 Fall from other slipping, tripping, or stumbling
Fall on moving sidewalk

E886 Fall on same level from collision, pushing, or shoving, by or with other person

Excludes: crushed or pushed by a crowd or human stampede (E917.1, E917.6)

E886.0 In sports

Tackles in sports

Excludes: kicked, stepped on, struck by object, in sports (E917.0, E917.5)

E886.9 Other and unspecified

Fall from collision of pedestrian (conveyance) with another pedestrian (conveyance)

E887 Fracture, cause unspecified

E888 Other and unspecified fall

Accidental fall NOS

Fall on same level NOS

E888.0 Fall resulting in striking against sharp object

Use additional external cause code to identify object (E920)

E888.1 Fall resulting in striking against other object

E888.8 Other fall

E888.9 Unspecified fall

Fall NOS

ICD-10 Codes for Causes of Falls

(only used for Fatality Data from 1999 on)*

W00 Fall on same level involving ice and snow

W01 Fall on same level from slipping, tripping, and stumbling

W02 Fall involving ice skates, skis, roller skates, or skateboards

W03 Other fall on same level due to collision with, or pushing by, another person

W04 Fall while being carried or supported by other persons

W05 Fall involving wheelchair

W06 Fall involving bed

W07 Fall involving chair

W08 Fall involving other furniture

W09 Fall involving playground equipment

W10 Fall on and from stairs and steps

W11 Fall on and from ladder

W12 Fall on and from scaffolding

W13 Fall from, out of, or through building or structure

W14 Fall from tree

W15 Fall from cliff

W16 Diving or jumping into water causing injury other than drowning or submersion

W17 Other fall from one level to another

W18 Other fall on same level

W19 Unspecified fall

Causes

Risk factors may be grouped into intrinsic factors, such as existence of a specific ailment or disease. External or extrinsic factors includes the environment and the way in which it may encourage or deter accidental falls.

Intrinsic factors

- Balance and Gait

  As a result of stroke disease, Parkinsonism, arthritic changes, neuropathy, neuromuscular disease or vestibular disease.

- Visual and Motor Reaction Time Problems

  An extended reaction time will delay responses and compensations to standing or walking imbalances, thus increasing the likelihood of falls.

- Medications
  - Polypharmacy is common in older people

    - Sedatives significantly increase the risk of falling
    - Cardiovascular medications can contribute towards falls
- Visual impairment
    - Glaucoma, macular degeneration and retinopathy increase the risk of falling
    - Bifocals and trifocals can increase the risk of falling as the lower portion of corrective lenses are optimized for distances approximately 18inches, thus precluding clear vision of one's feet/floor, approximately 4.5 to 5.5 feet below one's eyes.
- Cognitive problems
    - Dementia increases the likelihood of falls
- Cardiovascular causes
    - Orthostatic hypotension
    - Postprandial hypotension
    - Carotid sinus syndrome
    - Neurocardiogenic syncope– the commonest cause of syncope in A&E patients
    - Cardiac arrhythmias
    - Structural heart disease, such as valvular heart disease

Alcohol abuse–can cause instability from acute intoxication.

Alcohol abusers can be predisposed to falls secondary

to polyneuropathy, Wernicke encephalopathy, and
Korsakoff syndrome

Diabetes–related neuropathy can predispose one to
balance impairments, motor weakness, and loss of sensation,
leading to lower extremity weakness, which can
cause frequent tripping and inability to navigate stairs
and rise from a seated position

Extrinsic factors

Environmental factors can increase the risk of falls independently or, more importantly, by interacting with intrinsic factors. Risk is highest when the environment requires greater postural control and mobility (eg, when walking on a slippery surface) and when the environment is unfamiliar (eg, when relocated to a new home).poor lighting. poor fellow up safety measures in work place.

Situational factors

Certain activities or decisions may increase the risk of falls and fall-related injuries. Examples are walking while talking or being distracted by multitasking and then failing to notice an environmental hazard (eg, a curb or step), rushing to the bathroom (especially at night when not fully awake or when lighting may be inadequate), and rushing to answer the telephone

Mechanism of Injury :

During fall, the potential energy due to height is converted to kinetic energy under the influence of gravity. Fall from height, which results in injuries associated with rapid vertical deceleration; represent a unique form of blunt trauma. Victims of fall from height tend to sustain a unique pattern of injuries that depends on inertia of the body, movement of the body, rigidity of stationary objects and the nature of Ground nature against which body falls.

At the moment of impact**,** a falling body undergoes deceleration and amount of kinetic energy transferred to the Ground reacts with an equal amount against the Body itself. The body in the form of injuries reabsorbs the energy lost.

The frequency, type and extensiveness of injuries in falls from height are determined by body weight and velocity, nature of the surface impacted, duration and intensity of the impact force, body orientation in the moment of impact, as well as the elasticity and viscosity of the tissue of the contact body region.

The severity of the injuries can be explained by physics with the velocity of impact calculated using the following formula: v = H2gh. The

person at a height (h) above the ground is subjected to gravitational force(g) and its potential energy (Pe: m 9 g 9 h) is converted into kinetic energy (Ke: _ 9 m 9 v2) in a fall. This means a great amount of energy is transferred to that patient. Knowledge of injury patterns can help during the assessment of fall victims as they facilitate focus on specific areas. The characteristics of injuries and outcomes of vertical deceleration injuries depend on several factors: the level of the fall the landing position of the body; the surface onto which the victim falls age; and comorbidities of the patient. Knowledge of the injury patterns and the differences between those who jump and those who accidentally fall may help in the evaluation of these patients

Factors influencing magnitude of injury:

1. Falling height(distance)
2. composition of impact surface
3. Rate of deceleration
4. Age of persons (child ,adult ,elder)
5. Orientation of body on landing(impact)
6. Position of body while landing(impact)
7. Pre existing disease.

NEED FOR STUDY:

Ground Level Accidental falls are caused by patients or residents tripping, slipping and mostly the causes are due to environmental factors, example Unavailability of grab bars, Slippery floors due to spilled water and other factors Inadequate lightening, bed and toilets of inappropriate height Obstructed walkways, upended Carpets edges and raised door sills. Accidental falls cannot be predicated using any scale as other types but they can be prevented by modification of the environment by making it safer for all.

Fall From Height accidental fall is increasing yearly as the many work activities involve working at height. Many workers in maintenance, construction and many other people in a variety of jobs could be at risk of accidental fall, examples include painters, decorators, window cleaners and those who undertake one off jobs without proper training, planning or equipment. Accidental fall refers to fall from one higher level to another level involving ladder, stairs, roof, etc.

Review of literature:

1.Analyzed 75 cases of fatal ground-level falls that were investigated by the King County Medical Examiner over a 48-month period, with autopsies performed on 87% of the deaths: 69% of the cases were men and 61% occurred in ages ≥70 years; only 12% were aged <50 years, with the youngest aged 28 years. Most of the falls occurred in or about the residence, and many individuals were known to have fallen onto hard surfaces. . Basal skull fractures were present in 37% of cases, and acute subdural hematomas, the most common intracranial lesion, were present in 85%. We concluded that fatal ground-level falls were much more common in elderly persons, owing to a greater predisposition to falling, as well as intrinsic age-related changes, including a greater susceptibility to acute subdural hematoma

2.Study analyzed 237 fatal ground-level falls occurring in decedents aged 65 years or older reported to the Seattle-King County Medical Examiner's Office during the year 2007. Head injuries accounted for 109 (46%) of the deaths, and nonhead injuries accounted for 128 (54%) of the deaths. Falls occurred in similar locations in both groups. Compared with those of nonhead injuries, decedents of head injuries were younger (82 vs 87.5 years), were more often male (58% vs 45%), died sooner after their

injury (9 days vs 23 days), Subdural hematoma was the most common specific traumatic lesion, occurring in 86% of the decedents of head injury; skull fractures occurred in 13%.

3.Falling from a height is a common fatality circumstance in children.. Saukko& Knight (2004) describe the primary impact sites in falls. They state that depending on the point of impact, there may be a multitude of injury patterns and this can be variable. Most prevalent of these involve skull fractures, intracranial damage, vertebral and spinal damage and fractures to the long bones of the body (Saukko& Knight, 2004). The transmission of forces additionally results in fractures of sites of non-impact. For example, in a fall from height, the fall can end at the point of impact of the skull or the feet, and in both situations this can result in a ring fracture at the base of the skull around the foramen magnum. Saukko& Knight (2004) further emphasize the forensic importance of skull fractures in children as the interpretation of such fractures is complex and the delineation collateral history of the event (Shepherd & Simpson, 2003). It should be noted that the weight of children and their bony development will influence the mechanisms and injury patterns seen when compared to adult individuals (Shepherd & Simpson, 2003). The developmental age of a child/ infant and the associated neurodevelopment of the brain and its associated cranial vault

bones may influence the expression of skull fractures. Ibrahim et al., (2012) explored the influence of fall type and age on head injuries in a retrospective study. Primary findings highlighted that in low or immediate falls from heights, infants sustained more skull fractures then their older counterparts. Toddlers who fell from a low height sustained brain injury without

4.Deaths due to fall from heights are common in the State of Kerala. Majority of the cases are falls from tall trees and buildings. study was conducted in the Department of Forensic Medicine, Medical College, Trivandrum. The objective was to find out the nature and pattern of injuries sustained to the victims of fall from heights. Effort was made to find out the height of fall by visiting the scene of occurrence. The site of primary impact was identified from the analysis of injuries, statements of witness and records of the police. Majority of the cases were accidental falls. Of the 100 cases studied, accidents constituted 98%. There were only two cases of suicide. Most of the victims were active laborers in the age group of 20-60 years and the height of fall varied from 5-10 meters. Maximum numbers of primary head impacts were also noted in this group. Apart from injuries to skull and brain, involvement of cervical spine was a common feature. Visceral injuries were a common feature in trunk

impacts. Buttock impacts were characterized by fracture of pelvis and spine. Leg impacts showed fracture of leg bones and spine.

5.One hundred and seventy-four deaths of infants and children due to accidental fall from height received from South Delhi for autopsy were studied during the 10-year period from January 1998 to December 2007 at the All India Institute of Medical Sciences, New Delhi. Data were analysed with regard to age, sex, location of fall, height of fall, pattern of injury, cause of death and seasonal variation. These cases represented approximately 22.56% of all deaths due to a fall from height and 1.31% of all medicolegal autopsies conducted during the period. There were 106 male (60.9%) and 68 female (39.1%) victims. Age-specific rate of fall showed that the highest rate was in toddlers (39.65%), followed by 26.43% each in preschool children and school-going children and the least in infants (7.47%). The head and face was the most frequently injured body region (93.67%) and the skull was the commonest bone fractured (59.19%). The most common cause of death was head injury (84.48%). Major fall sites in decreasing order of frequency were rooftop (38.50%), balcony (24.13%), household furniture (21.26%), staircase (6.89%), window (4.59%), wall (1.72%), rickshaw/bicycle (1.15%) and tree (0.57%).

6.The study was to identify the pattern of head injuries in victims of fall aged 0-10 years and its correlation with height. This prospective was study done at JNMCH, Aligarh, on 173 patients who came to the casualty during a 12-month period (January 1, 2011 to December 31, 2011) sustained a fall from a height ranging from 0-9 feet. Male: female ratio was 1.5:1. Most of the falls (150 cases, 86.71%) were from a height of 6-9 feet. Out of 173 cases, skull fractures were seen in 144 cases (83.24%) and intracranial injuries occurred in 118 cases (68.20%). The most common fracture was linear undisplaced fracture and was observed in 126 cases (126/144; 87.5%) and the most common intracranial injury was extra-axial bleed seen in 70 cases (70/118; 59.32%). The severity of injury was strongly correlated with height of the fall.

7.In a Multi-centric Community Study, evaluating Health Problems in the Elderly (Year 2003), in 10 states across India, covering a total population of 10,200 elderly with equal rural and urban distribution, the incidence of falls (History of a single fall in the last 6 months) was found to be 14% (Data to be published)

Among the 35 states and union territories in India, Kerala has registered the highest proportion of elderly. The aged in Kerala constitute 11% of the population. Between 1961 and 1991, there has been 160% increase in the population of older adults, the majority of them being

women. Their population, which was 9% in 1991, is expected to increase to 37% by 2051.

The Kerala Aging Survey (KAS), conducted among more than 5,000 elderly (2,271 men and 2,722 women) in 14 districts of Kerala, was the keystone of the study. The results of the survey have shown that the age of participants ranged from 60 to over 100 years of age with 54% being women. The results of the study show that falls and fractures are a significant issue among older adults

8. Joshi, Rajesh Kumar and Avasthi (2003) conducted a cross-sectional survey of 200 subjects over 60 years old (100 each from the urban population of Chandigarh City and the rural population of Haryana State of India) was carried out using a cluster sampling technique. The study period was July 1999–April 2000. Various socio-demographic characteristics were recorded at baseline. A clinical diagnosis was made by a physician based on reported illness, clinical examination, and cross-checking of medical records and medications held by the subjects. Psychological distress and disability was assessed using the PGI Health Questionnaire-N-1 and the Rapid Disability Rating Scale-2, respectively.

ANOVA, Kruskal–Wallis H test, correlation coefficient, and multivariate analysis were used to assess the relationship and association of morbidity with other variables.

Assessment of the morbidity profile and its determinants will help in the application of interventions, both medical and social, to improve the health status and thus the quality of life of the elderly in Northern India. The distribution of history of fall among elderly people over 60 years old shows that, out of the total sample population, 103 (51.5%) subjects had fallen. Fracture was reported in 21.3%, and other injuries occurred in 79.6% of those who had fallen. Fractures among females (26.4%) were reported more frequently compared with males (16%) and fracture was seen more in urban subjects (29.4%) compared with rural subjects (13.4%). History of fall and fall frequency was seen to be significantly associated with disability and psychological distress. Higher disability and consequent increasing distress was noted among those with a prior history of fall after 60 years of age and those with a history of three or more falls. The significance of falls among elderly people is that not only that the number of falls increases with age but the injury rate is highest among the oldest old (80 years) subjects with history of falling more than twice. There is a vicious cycle where, due to poor perceived health and morbidity there is increased tendency to fall which itself leads to increasing disability and

distress. Relationship of morbidity profile with disability and psychological distress

9. Rashmi and Lalita (2005) in a presentation has pointed out that hip fractures in elderly people are almost always the result of falls. Regular exercise increases muscle strength, coordination and flexibility and reduces the tendency to fall.

Exercise reduces the risk of falling by 10%, and balance training programs reduces the risk by nearly 20%. The elimination of environmental hazards, the avoidance of drugs which impair balance and management of neuromuscular disorders play a role in fracture prevention (Wark, 1993

10.Johnson (2006) examined the frequency and nature of falls and fall-related injuries among older women in the state of Kerala, India. The study involved 82 community living and 63 institutionalized women aged 60 years or older in Trivandrum, Kerala, India. Demographic data and falls profile were collected through the use of a field survey. A significantly lower percentage (45%) of community dwelling participants suffered a fall in the previous year, compared to 64% of those in the Long Term Care (LTC) settings ($p < .05$). Overall, of those who fell, 74% reported an injury (e.g., cuts and bruises, fractures) as a result of the fall, and 48% of older adults in the community and 70% in the LTC setting required medical

treatment as a result of the falls. Falling is emerging as a significant public health problem facing older women in the state of Kerala. Fall prevention strategies to address falls should be explored and implemented within the Indian context.

It is estimated that nearly 1.5 to 2 million persons are injured and 1 million succumb to death every year in India. Gururaj (2002) has found that road traffic injuries are the leading cause (60%) of traumatic brain injuries followed by falls (20%-25%) and violence (10%).

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MATERIALS AND METHODS

Source of data:

Data will be collected from the medico legal autopsies of all cases of accidental fall (U/S 174 Crpc) autopsied at the Mortuary of Madurai Medical College Madurai from the period of January 2016to December 2016.

Method of collection of data:

i) From all the **medico** legal autopsies&autopsy reports of cases of accidental fall (U/S 174 Crpc) autopsied at the Mortuary of Madurai Medical College Madurai from the period of January 2016 to December 2016.

ii) .Autopsy was conducted by Lettule's method of en masse removal of viscera and dissection of organs. After noting the visceral injuries, head chest, vertebral column, buttocks, upper and lower limbs were examined for primary impact injuries.

i) The areas which showed infiltration with blood, the examined for primary area was cleaned, dissected and examined to assess the nature and extent of injury .Photographs were taken wherever possible. Blood and urine were collected and sent for chemical analysis when there was suspicion of consumption of ethyl alcohol/drugs. In the case of victims who had undergone treatment prior to death, clinical data was also obtained.

ii) Apart from recording the nature and pattern of injuries, data regarding the nature of fall, site of primary impact, period of survival etc. were obtained from the investigating officers. In all cases, the height of fall has been determined by enquire the investigation officer ,crime scene photograph and if necessary visiting the crime scene and taking measurements. Special effort was made to find out precipitating causes like epilepsy, mental illness, natural diseases and use of drugs or alcohol. A detailed examination was made and data was entered in a proforma. This included search for external and internal injuries, their nature, dimensions and location.

The data in the form of age, sex, date/day of incident, place of fall, height s of fall ,time of fall, surface of fall, death since fall, primary impact, pattern of injuries , cause of death, including of any hospitalization and treatment, charting in the form of proforma in detail, After tabulating and analyzing the data - mean, median , mode, percentages, range are calculated.

The criteria used for selection of cases for this study are as follows :

Inclusion criteria :

All the medico legal autopsies, autopsy reports and hospital records of accidental fall cases at the Mortuary of Medical College, Madurai during January 2016 to December 2016.

Exclusion criteria :

1. Decomposed cases
2. Unknown cases
3. Cases where history and details not available
4. Fall from moving vehicle (road traffic and train traffic accident)
5. Fall from burning building
6. Fall into fire
7. Fall into water (with submersion or drowning)
8. Fall into machinery (in operation)

RESULTS

The study consisted of 210 victims of accidental fall, subjected to autopsy in mortuary of Madurai Medical College and Government Rajaji Hospital, Madurai for the period of one year between January 2016 to December 2016 .

Total number of autopsies done during the above period was 3406.

Total number of victims of accidental fall during the above period: 210(6.16%).

The present study reveals incidence of accidental fall of 6.16%.

Ground level fall – 54.8% (115 victims)

Fall from height – 45.2% (95 victims)

Height of fall	No.of cases	%
GROUND LEVEL FALL (SAME LEVEL FALL)	115	54.8
FALL FROM HEIGHT	95	45.2
Total	210	100.0

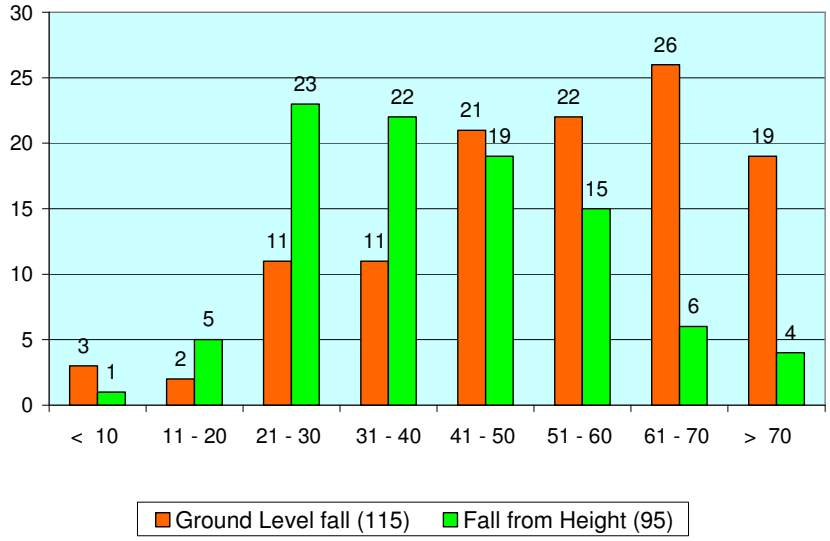
AGE:

GROUND LEVEL FALL:

Age range starts from 4 years -85 years. The incidence peaked in the age group 61-70 years constituting 22.6 %(n=26) of the cases. 19.1% (n=22) of the victims belonged to the age group 51-60. Hence 39.1% of victims belonged to the age group of more than 60 years. Individuals <20 years were the least affected (4.3%, n=5).

	Ground Level fall (115)		Fall from Height (95)	
Age in years	No.of cases	%	No.of cases	%
< 10	3	2.6	1	1.1
11 - 20	2	1.7	5	5.3
21 - 30	11	9.6	23	24.2
31 - 40	11	9.6	22	23.2
41 - 50	21	18.3	19	20.0
51 - 60	22	19.1	15	15.8
61 - 70	26	22.6	6	6.3
> 70	19	16.5	4	4.2
Total	115	100.0	95	100.0

AGE DISTRIBUTION



FALL FROM HEIGHT:

Age ranged from 1 year- 75 years. The incidence peaked in the age group 21-30 years constituting 24.2%(n=23) of the cases.23.2%(n=22) victims belonged to the age group 31-40 years. Hence 45.4% of victims belonged to the age group between 21-40 years. Individuals <10 years (1%,n=1) and >60 years(10.5%,n=10) were the least affected.

SEX DISTRIBUTON:

GROUND LEVEL FALL:

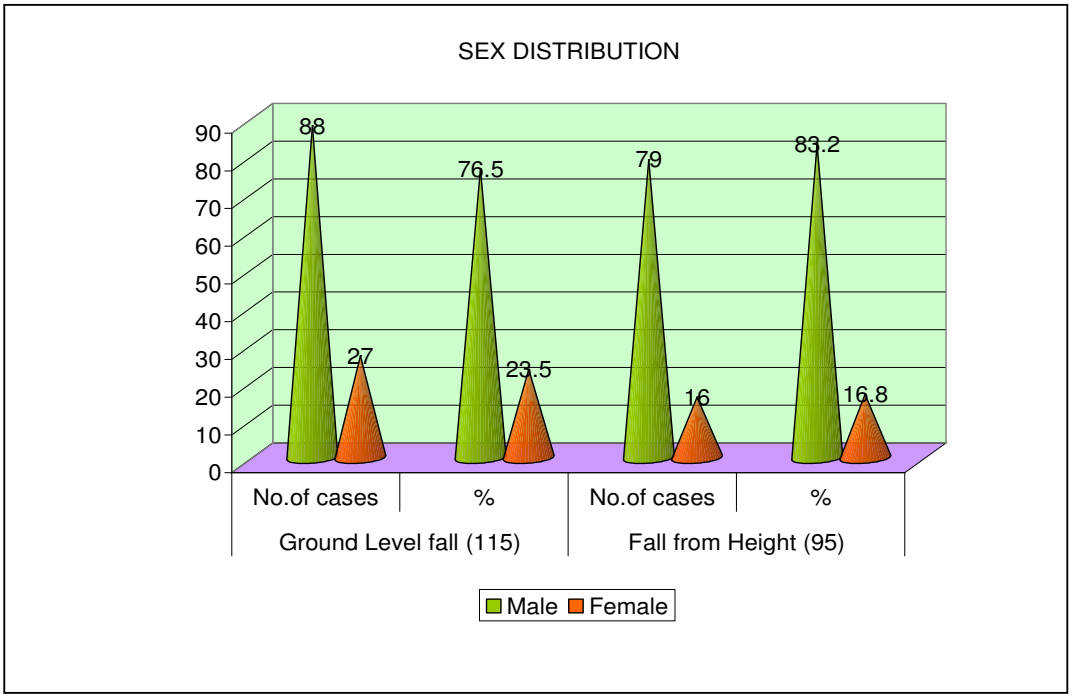
88 males constituting 76.5% were the victims of ground level fall while only 27 females constituting 23.5% were the victims of ground level fall. SEX RATIO was 3.3:1

FALL FROM HEIGHT:

79 males constituting 83.2% were the victims of fall from height while only 16 females constituting 16.8% were the victims of fall from height.

SEX RATIO was 4.9:1

	Ground Level fall (115)		Fall from Height (95)	
Sex Distribution	No.of cases	%	No.of cases	%
Male	88	76.5	79	83.2
Female	27	23.5	16	16.8
Total	115	100.0	95	100.0



FALL FROM HEIGHT:

79 males constituting 83.2% were the victims of ground level fall while 16 females constituting 16.8% were the victims of ground level fall.

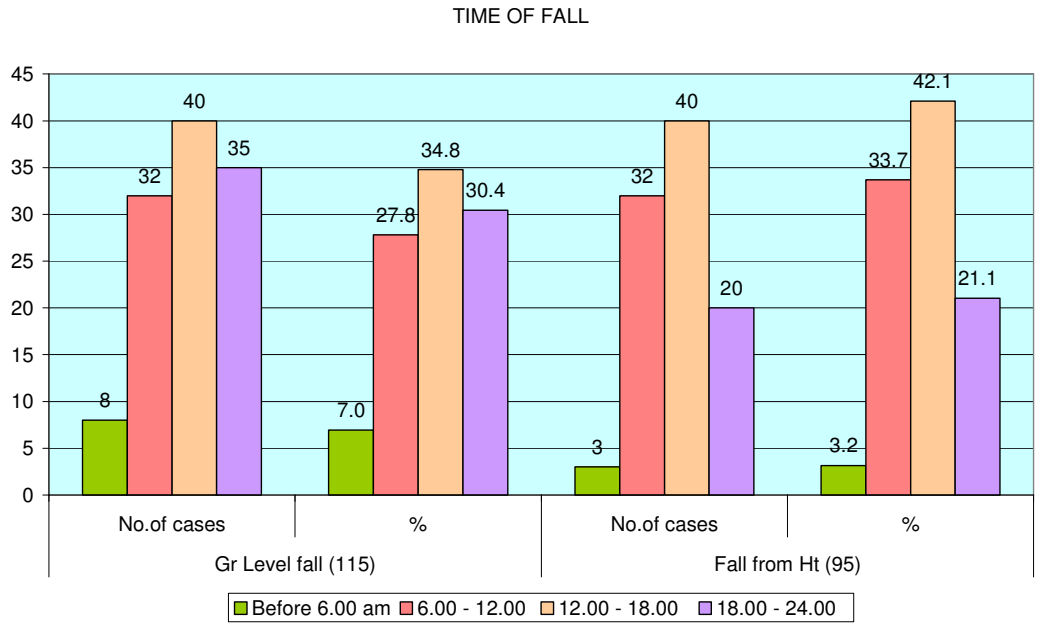
SEX RATIO was 4.9:1

TIME OF FALL:

GROUND LEVEL FALL:

Most cases of ground level fall occurred between 12noon – 6 p.m. i.e., during afternoon and evening (n=40, 34.8% cases). Least number of falls occurred during 12 midnight – early morning 6a.m. (n=8,7% cases).

	Gr Level fall (115)		Fall from Ht (95)	
Time of fall	No.of cases	%	No.of cases	%
Before 6.00 am	8	7.0	3	3.2
6.00 - 12.00	32	27.8	32	33.7
12.00 - 18.00	40	34.8	40	42.1
18.00 - 24.00	35	30.4	20	21.1
Total	115	100.0	95	100.0



FALL FROM HEIGHT:

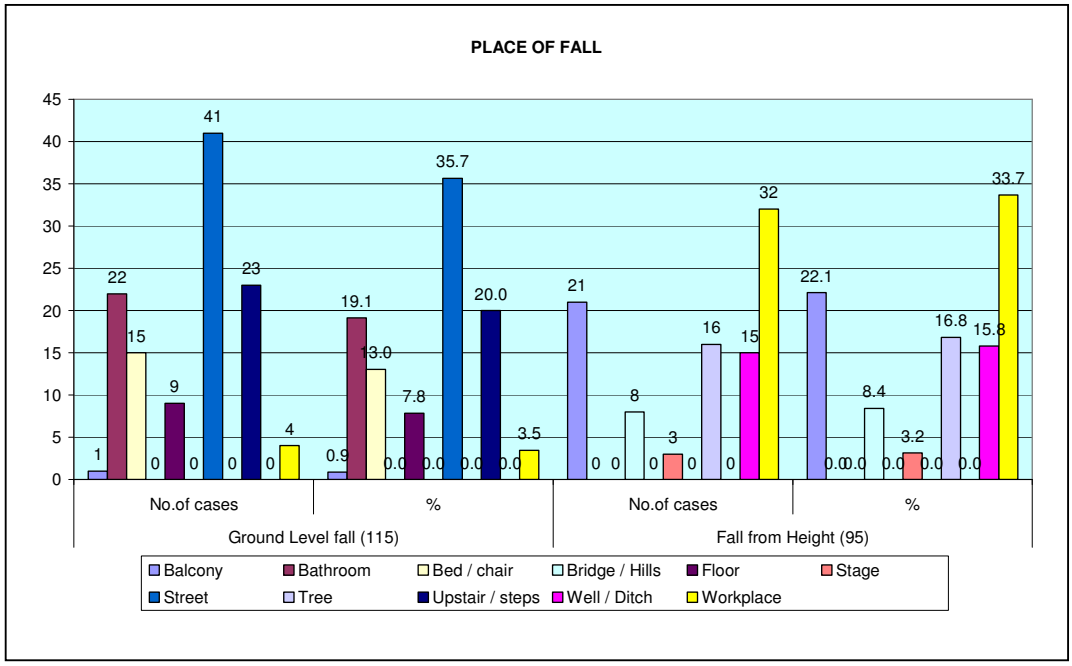
Most cases of fall from height occurred between 12 noon – 6 p.m. i.e., during afternoon and evening (n=40, 42.1%). Least number of falls occurred during 12 midnight – early morning 6a.m. (n=3, 3.2% cases).

PLACE OF FALL:

GROUND LEVEL FALL:

In most victims death was due to indoor ground level fall- falls in Bathroom, bed/chair and floor constituted around 40%(n=46) followed by outdoor ground level falls- streets and balcony, constituting 36.5%(n=42).

	Ground Level fall (115)		Fall from Height (95)	
Place of fall	No.of cases	%	No.of cases	%
Balcony	1	0.9	21	22.1
Bathroom	22	19.1	0	0.0
Bed / chair	15	13.0	0	0.0
Bridge / Hills	0	0.0	8	8.4
Floor	9	7.8	0	0.0
Stage	0	0.0	3	3.2
Street	41	35.7	0	0.0
Tree	0	0.0	16	16.8
Upstair / steps	23	20.0	0	0.0
Well / Ditch	0	0.0	15	15.8
Workplace	4	3.5	32	33.7
Total	115	100.0	95	100.0



FALL FROM HEIGHT:

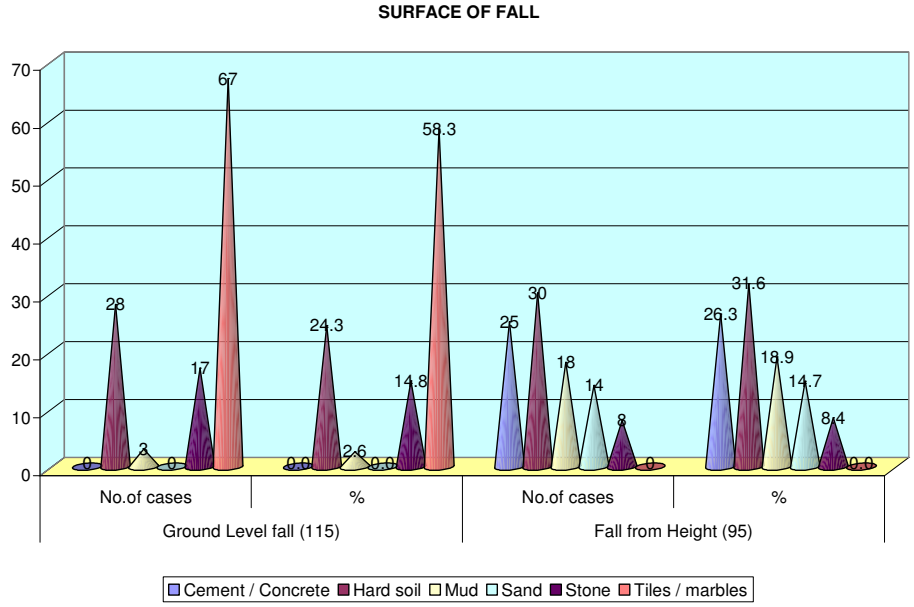
In most victims death was due to fall from height in workplace mainly construction work sites which constituted 33.7 %(n=32) followed by fall from balcony (n=21, 22.1%) and tree (n=16, 16.8%)

SURFACE OF FALL:

GROUND LEVEL FALL:

Most common surface of indoor ground level fall was tiles and marbles (n=67, 58.3%) followed by hard soil (n=28, 24.3%)

	Ground Level fall (115)		Fall from Height (95)	
Surface of fall	No.of cases	%	No.of cases	%
Cement / Concrete	0	0.0	25	26.3
Hard soil	28	24.3	30	31.6
Mud	3	2.6	18	18.9
Sand	0	0.0	14	14.7
Stone	17	14.8	8	8.4
Tiles / marbles	67	58.3	0	0.0
Total	115	100.0	95	100.0



FALL FROM HEIGHT:

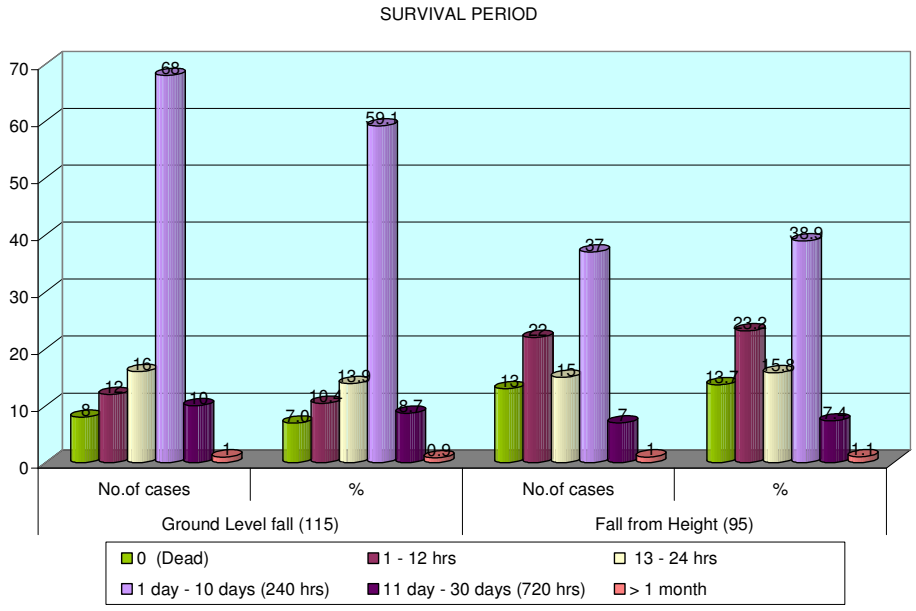
Most common surface of deaths due to fall from height was hard soil in working place (n=30,31.6%) followed by cement & concrete (n=25, 26.3%) and Mud (n=18, 18.9%)

SURVIVAL PERIOD:

GROUND LEVEL FALL:

Out of 115 cases of ground level fall , 68 cases survived for 1-10 days constituting 59%, less than 1 day survivors were 28 constituting 24.3%. 8 cases were brought dead. 1 victim was the longest survivor who succumbed to death after 1 month of survival period.

	Ground Level fall (115)		Fall from Height (95)	
Survival period	No.of cases	%	No.of cases	%
0 (Dead)	8	7.0	13	13.7
1 - 12 hrs	12	10.4	22	23.2
13 - 24 hrs	16	13.9	15	15.8
1 day - 10 days (240 hrs)	68	59.1	37	38.9
11 day - 30 days (720 hrs)	10	8.7	7	7.4
> 1 month	1	0.9	1	1.1
Total	115	100.0	95	100.0



FALL FROM HEIGHT:

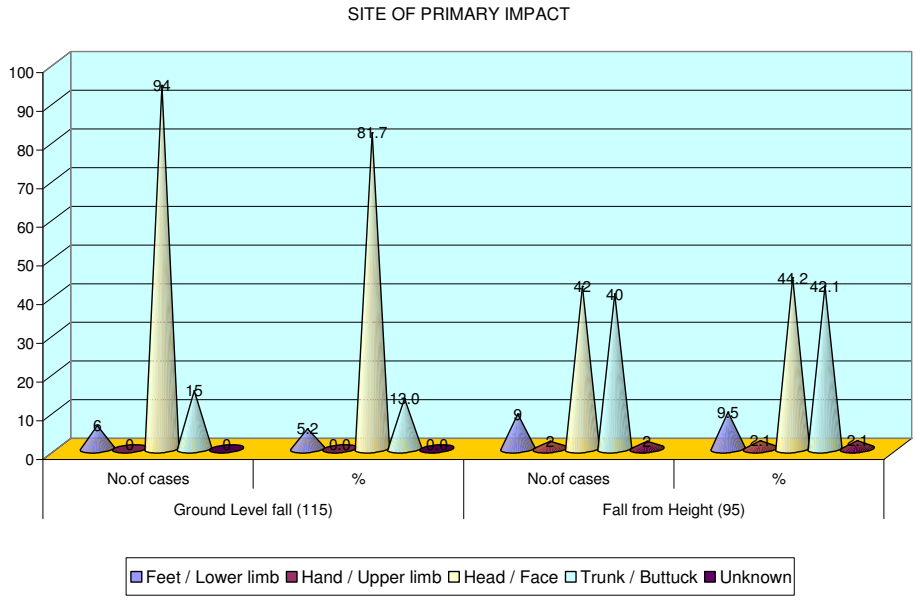
37 victims survived less than 24 hours constituting 38.9% followed by 37 cases who survived for 1-10 days. 13 cases were brought dead.

PRIMARY IMPACT:

GROUND LEVEL FALL:

Commonest site of primary impact was Head & Face constituting 81.7%(n=94) followed by trunk & buttocks constituting 13%(n=15) and then Feet/Lower limb constituting 5.3%(n=6).

	Ground Level fall (115)		Fall from Height (95)	
Site of primary impact	No.of cases	%	No.of cases	%
Feet / Lower limb	6	5.2	9	9.5
Hand / Upper limb	0	0.0	2	2.1
Head / Face	94	81.7	42	44.2
Trunk / Buttuck	15	13.0	40	42.1
Unknown	0	0.0	2	2.1
Total	115	100.0	95	100.0



FALL FROM HEIGHT:

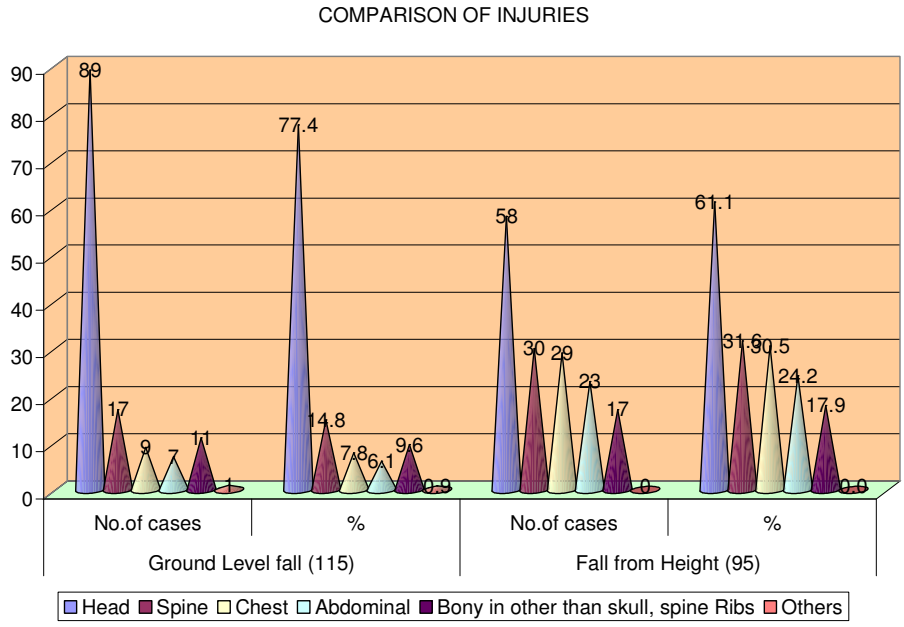
Commonest site of primary impact was again Head & Face constituting 44.2%(n=42) followed by trunk & buttocks constituting 42.1%(n=40) and then Feet/Lower limb constituting 9.5%(n=9).

INJURY PATTERN:

GROUND LEVEL FALL:

Commonest injury in ground level fall victims was Head injury constituting 77.4% (n=89) followed by spine injury constituting 14.8% (n=17) and then major bone injuries constituting19.6%(n=11), chest injuries 9.8%(n=9) and least was abdominal injuries(7 cases , 6.1%).

	Ground Level fall (115)		Fall from Height (95)	
Injuries	No.of cases	%	No.of cases	%
Head	89	77.4	58	61.1
Spine	17	14.8	30	31.6
Chest	9	7.8	29	30.5
Abdominal	7	6.1	23	24.2
Bony in other than skull, spine Ribs	11	9.6	17	17.9
Others	1	0.9	0	0.0



FALL FROM HEIGHT:

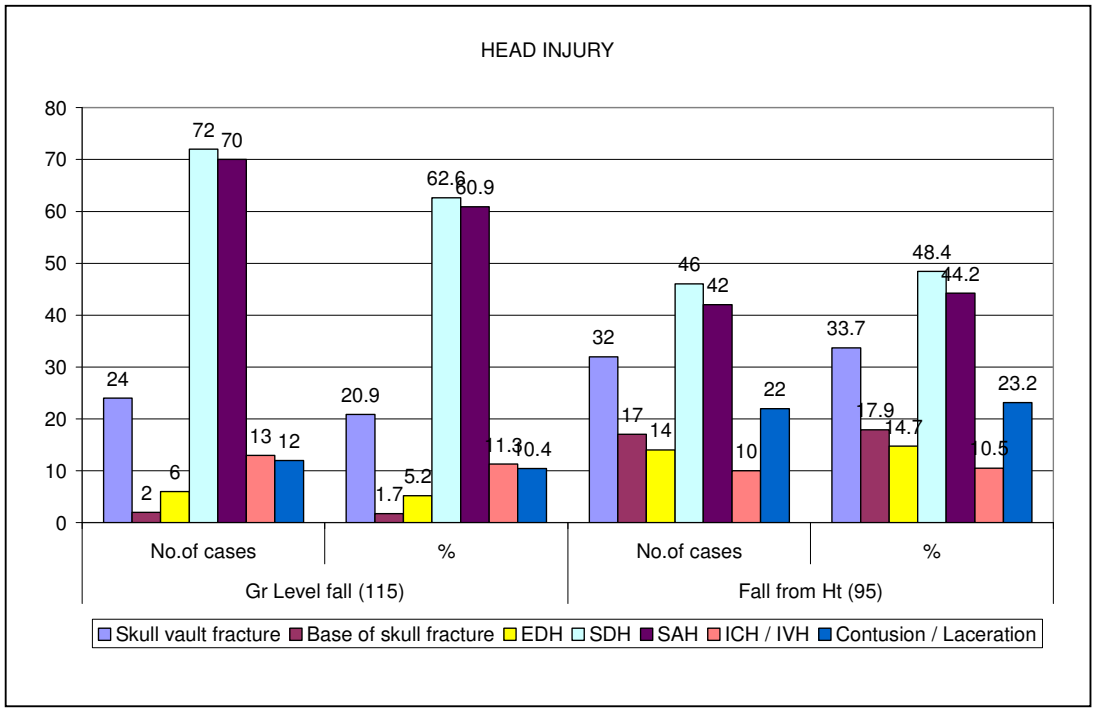
Most common injury in victims of deaths due to fall from height was again Head injury constituting 61.1% (n=58) followed by spine injury constituting 31.6% (n=30), then chest injuries 30.5 %(n=29), abdominal injuries 24.2%(n=23) and least was major bone injuries 17.9%(n=17).

HEAD INJURY:

GROUND LEVEL FALL:

89 victims died due to Head injury from Ground level fall. Commonest pattern of injury among head injury victims was subdural haemorrhage constituting 62% (n=72) followed by subarachnoid haemorrhage (n=70, 60.9%). Least common injury was contusion/laceration of brain (n=12, 10.4%). Among skull fractures, vault fractures (n=24) were more common than basal fractures (n=2).

Head Injury (147)	Gr Level fall (115)		Fall from Ht (95)	
	No.of cases	%	No.of cases	%
Skull vault fracture	24	20.9	32	33.7
Base of skull fracture	2	1.7	17	17.9
EDH	6	5.2	14	14.7
SDH	72	62.6	46	48.4
SAH	70	60.9	42	44.2
ICH / IVH	13	11.3	10	10.5
Contusion / Laceration	12	10.4	22	23.2
Total	89	77.4	58	61.1



FALL FROM HEIGHT:

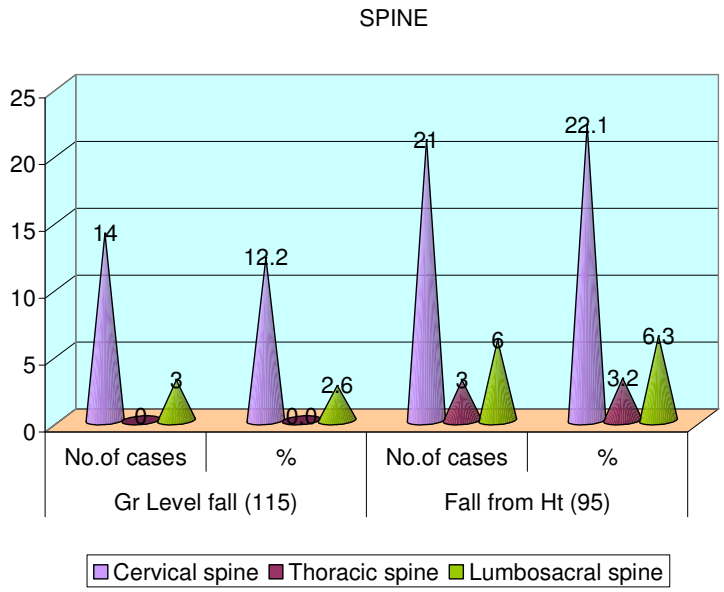
58 victims died due to Head injury from fall from height. Commonest pattern of injury among head injury victims was subdural haemorrhage constituting 48.4% (n=46) followed by subarachnoid haemorrhage (n=42, 44.2%). Number of skull fractures both base and vault seen in more number of victims than ground level fall. Contusion/laceration of brain was comparatively higher than ground level fall.

SPINE INJURY:

GROUND LEVEL FALL:

Cervical spine injury was the commonest contributing to 12.2%(n=14) followed by Lumbosacral spine injury constituting 2.6%(n=3)

Spine (47)	Gr Level fall (115)		Fall from Ht (95)	
	No.of cases	%	No.of cases	%
Cervical spine	14	12.2	21	22.1
Thoracic spine	0	0.0	3	3.2
Lumbosacral spine	3	2.6	6	6.3
Total	17	14.8	30	31.6



FALL FROM HEIGHT:

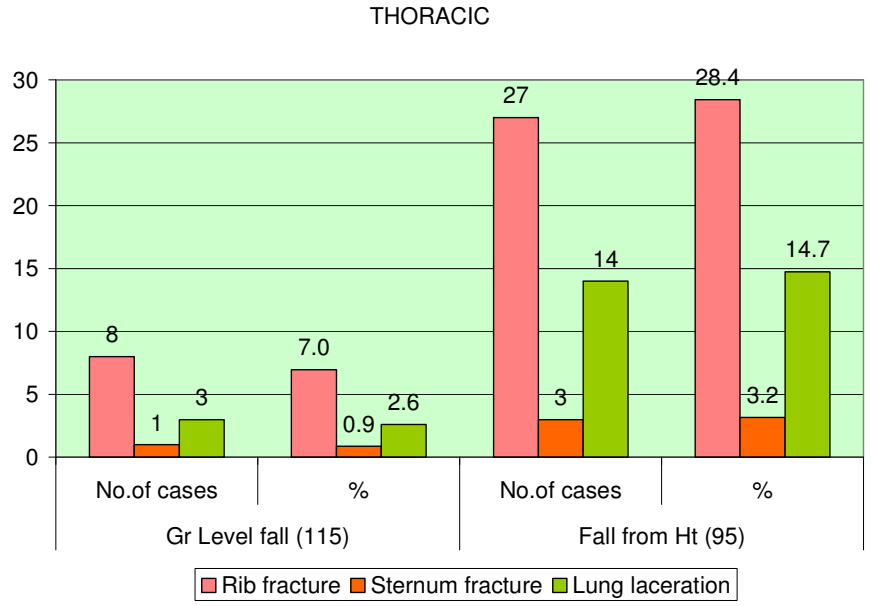
Again Cervical spine injury was the commonest contributing to 22.1%(n=21) followed by Lumbosacral spine injury.

Thoracic spine injury was seen in deaths due to fall from height while it was not observed in deaths due to ground level fall.

CHEST INJURY:

More chest injuries were common in victims who had fall from height (n=29) than ground level fall victims (n=9). In case of rib fractures, sternal fractures and lung lacerations , the number of victims were higher in fall from height than in ground level fall.

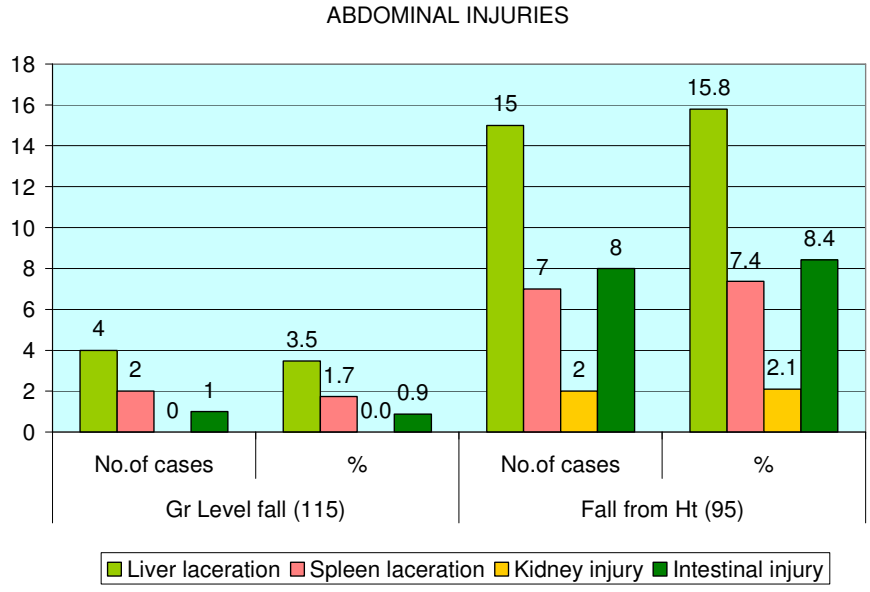
Thoracic (38)	Gr Level fall (115)		Fall from Ht (95)	
	No.of cases	%	No.of cases	%
Rib fracture	8	7.0	27	28.4
Sternum fracture	1	0.9	3	3.2
Lung laceration	3	2.6	14	14.7
Total	9	7.8	29	30.5



ABDOMINAL INJURY:

Commonest solid organ injuries in abdominal cavity were observed in liver followed by spleen in both ground level fall and fall from height victims. Kidney, being a retroperitoneal organ was injured only in few cases of deaths of fall from height (n=2).

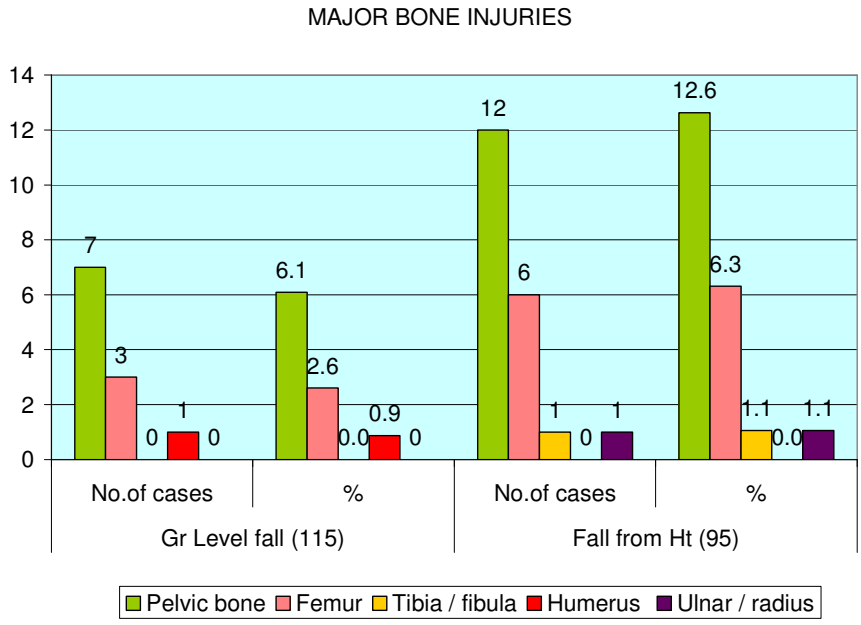
Abdominal Injuries(30)	Gr Level fall (115)		Fall from Ht (95)	
	No.of cases	%	No.of cases	%
Liver laceration	4	3.5	15	15.8
Spleen laceration	2	1.7	7	7.4
Kidney injury	0	0.0	2	2.1
Intestinal injury	1	0.9	8	8.4
Total	7	6.1	23	24.2



MAJOR BONE INJURY:

Major bone injuries were more common in victims of fall from height than ground level fall victims. Among the major bones pelvic bone is the commonest to get injured (19 cases) followed by femur (9 cases). Bones of upper limb were the least commonly injured.

Major Bone Injuries (28)	Gr Level fall (115)		Fall from Ht (95)	
	No.of cases	%	No.of cases	%
Pelvic bone	7	6.1	12	12.6
Femur	3	2.6	6	6.3
Tibia / fibula	0	0.0	1	1.1
Humerus	1	0.9	0	0.0
Ulnar / radius	0	0	1	1.1
Total	11	9.6	17	17.9



CAUSE OF DEATH

GROUND LEVEL FALL:

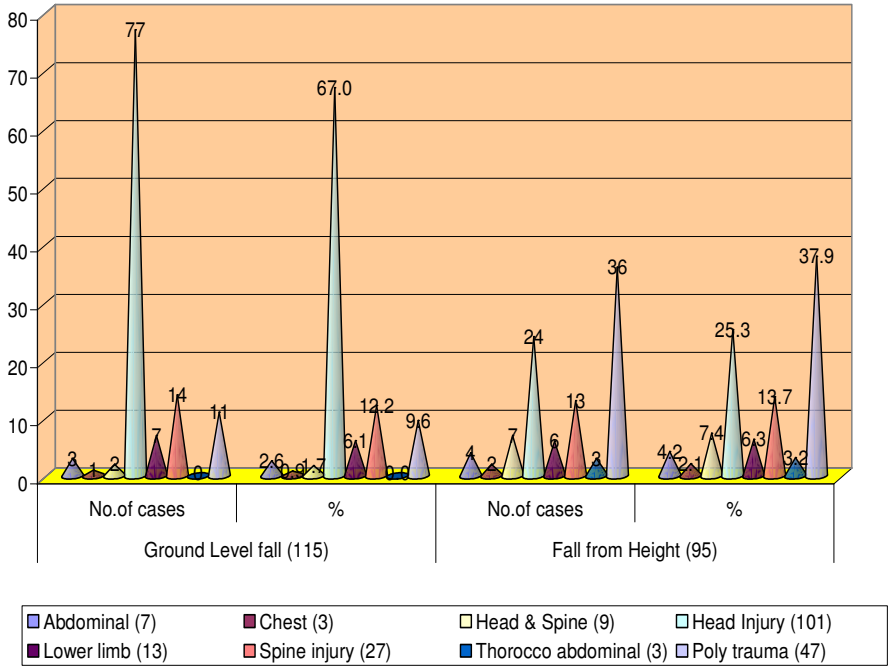
Head injury was the major cause of death in ground level fall victims. 77 victims (67%) had died due to head injury followed by spine injury.

FALL FROM HEIGHT

Polytrauma was the major contributor of mortality in fall from height victims.36 victims (37.9%) had poly trauma head injury again had a major role . 24 cases died of head injury.

	Ground Level fall (115)		Fall from Height (95)	
Causes of Death	No.of cases	%	No.of cases	%
Abdominal (7)	3	2.6	4	4.2
Chest (3)	1	0.9	2	2.1
Head & Spine (9)	2	1.7	7	7.4
Head Injury (101)	77	67.0	24	25.3
Lower limb (13)	7	6.1	6	6.3
Spine injury (27)	14	12.2	13	13.7
Thorocco abdominal (3)	0	0.0	3	3.2
Poly trauma (47)	11	9.6	36	37.9
Total	115	100.0	95	100.0

CAUSES OF DEATH



DISCUSSION

EPIDEMIOLOGICAL PROFILE AND PATTERN OF INJURY IN GROUND LEVEL FALL

The present study revealed higher number of cases seen in older age group >60 years. Maximum incidence was in the age group 61-70 years constituting 22.6% cases.

Falls increase with age and increasing fragility. Falls are the most common mechanism of injury in the elderly age group and also the leading cause of trauma related death. Elderly people have lower limb weakness, disorders of balance like vertigo, postural hypotension, and Central nervous disorders like transient ischemic attacks, cognitive disorders, on drugs & medications for comorbidities, all these factors favouring their susceptibility to falls.

Ground level fall least incidence in the age group of <20 years. Thewell-co-ordinated Central Nervous System & motor system in young individuals making them less susceptible to falls except in few rare occasions.

Males predominant over females by nearly 3 times.

Our study shows most of the incidents are Indoor. Victims fall mainly bathroom, floor and mostly evening and night.

Mostly primary impact was Head and face leading to Head Injury followed by cervical Spinal Injury. Among head injury victims Sub Dural Hematoma(SDH) followed by Subarachmoid Haemorrhage(SAH) were the common lesions with few cases of vault fractures.

In cervical spine Injuries commonest site was C_5C_6 .

The forces generated by falling from a standing height are at the threshold of what is needed to produce a serious head injury, and the stiffiness of the impacting surface is a major factor determining the consequence of a simple fall. Furthermore elderly individuals fall differently from younger ones and their cerebral anatomy predisposes to developing a Sub Dural Hematoma (SDH).

Among Non skull fracture victims mainly cervical spine fracture followed by rib fractures were observed. Few cases of Pelvic bone & femur fracture were also noted.

In Visceral organ liver laceration, spleen laceration and few cases of lung laceration were noticed.

Among the cause of death, Head Injury is the major contributor. In Non-Head injury victims - spine fracture and thoraco abdominal injuries were the contributing factors.

Study by Dr**.R.Bardaleet al**[14] shows more victims were males aged >65 years and incident occurred mainly Indoor similar to our study.

Contrasting to the study, our study recorded time of incidents more in the evening.

Survival period in the study was parallel to our study results. Among Injuries most of the victims of ground level fall had Head Injuries mainlySub Dural Hematoma(SDH). Contrast to our study 1 case died to cardiac tamponade consequent to Chest Injury.

The pattern of injuries in Non-Head Injury victims were similar to the patterns in our study.

Karen M. Chisholm and Richard C.Harruff[15] in their study recorded most victims were male>80 years and almost 79% of indoor falls mainly fall on marbles & tiles like our study.

Among injuries number of Head Injury victims equalled the number of Non-Head Injury victims contrasting to our study.

Among Head Injury victims Sub Dural Hematoma (SDH)&Sub Arachmoid Haemorrhage(SAH) were the more prevalent lesions.

In victims of anticoagulant intake, ever a minor trauma had asignificant risk of Sub Dural Hematoma(SDH).

Among Non-Head Injury victims in most of the victims pelvic bone fracture were prevalent followed by cervical spine fracture & femur fracture. Women were more likely to have pelvic bone fracture. But our study had women with least pelvic bone fracture.

Study by **Saab M, Gray A, Hodgkinson D et el**[20] reported that patients on anticoagulation therapy have a 10 fold increase in developing intracranial hemorrhage after sustaining minor head trauma compared with those not an anticoagulation theraphy.

Oakley A,Dawson MF, Holland J ,et al[22] **and Close J, Ellis M, Hooper R et al**[23] studies show Vitamin D & Calcium Supplementation have been found to reduce the risk of falls in older age groups.

Seleye-Fubara and Ekere[17]study on domestic accidental deaths in Nigeria revealed most of the victims were males among them, was a bimodal age distribution. 24.1% of preschool children & 26.5% elderly over 70 years. Ground Level Fall constituting the most common mechanism of injury in elderly.

Annette Thierauf et al[11]pointed out occipital lacerations were found significantly more often in ground level falls under the influence of alcohol compared to falls with no previous consumption of alcohol.

Kannus Pet al[16] study on geriatric trauma revealed concordant results with elderly people more prone to falls.

Velmahoset al[13] quoted 301 cases of fatal ground level fall in elderly aged >55 years.

Sterling et al[12] showed similar results with 48% of victims in the age group >65 years.

EPIDEMIOLOGICAL PROFILE OF FALL FROM HEIGHT

AGE

PEAK INCIDENCE 21- 40 years

LEAST INCIDENCE <10years &>60 years

Most people in the age group 21-40 years being earning member of the family were more prone to fall at work places. Children <10 years and adults >60 years being the dependent population had comparatively less injuries due to fall from height.

Study by **Bharath Kumar Guntheti &Uday Pal Singh**[25] revealed most victims were in the age group 20-30 years. Studies by **Albert Goonetillekke**[28]&**Lalwaniet al**[29] also gave parallel results.

V.Prathapan& B.Umadethan[34] in their study pointed out that most of the victims were in the age group of 40-49 years in contrast to our study.

SEX

STUDY RESULT

Males predominant over females by nearly 5 times.

Males being the head of the family and earning member in our society are more prone to workplace injuries due to fall from height.

Study by **Bharath Kumar Guntheti &Uday Pal Singh**[25] shows male victims dominating female victims with a male:female ratio of 9:6.

Studies by **Atanasijevic et al,**[26] **Tahir& Robert,**[27] **Albert Goonetillekke&Lalwani et al**[28] also showed comparable male preponderance in deaths due to fall from height.

TIME OF INCIDENCE

PEAK INCIDENCE during afternoon and evening (12 noon- 6 pm)

LEAST INCIDENCE 12 midnight -6 am

Most falls were occurring during afternoon presumably because the working hours at construction sites is daytime and the workers being fatigued in the evening time making them susceptible to falls. Study by **Turk E &Tsokos M** [30]**, stevens JA et al** [31]**and Stephenie& Andrea**[32]showed similar results with maximum number of falls between 12 pm – 6 pm . Study by **Bharath Kumar Guntheti&Uday Pal Singh**[25] revealed analogous results.

Study by **Jegannathan et al**[37]showed that most of the victims were workers aged 21-30 years contributing to day time fall.

Contrast to our study **Kohli&Banerjee**[24] studyshowed most falls in night.

SURFACE OF FALL

Most common surface of fall – Hard soil followed by cement / concrete at work place.

The inadequate safety measures again can be correlated with the more number of falls on Hard soil,cement /concrete at work places. Also fall on Hard soil, the victims at risk of more severe (both external and internal injuries). Fall on mud causes more blunt injuries.

Studies by **V.Prathapan&B.Umadethan**[34]**,Vasudeva Murthy et al** [35] **and J.V.Kirankumar et al**[36] revealed results comparable to our study.

PLACE OF FALL

Most common place of fall in urban area was construction site and in rural places – trees.

Lack of proper safety measures at construction sites implies more fall from heights at work places.

Likewise more number of trees in villages being the reason for fall from height in rural areas.

Turk E &TsokosM[30] **,stevens JA et al**[31] **and Stephenie& Andrea**[32]**and Steedman DJ**[33] studies revealedconcordant results with most victims died due to fall in construction sites.

Study by **Bharath Kumar Guntheti&Uday Pal Singh**[25]also gave similar results. **J.V.Kirankumaret al**[36] shows 2/3 rd of fall occurred at home mainly balcony & veranda which was contrasting to our study. Study by **V.Prathapan& B.Umadethan**[34]shows most common fall from tree contrasting results to our study.

SURVIVAL PERIOD

Victims who fall from height are more vulnerable to polytrauma consequently their survival was very short as less than 24 hours .**Bharath Kumar Guntheti&Uday Pal Singh**[25] study shows more than 50% of victims died in less than 24 hours, **stevens JA et al** [31]**&Elisabeth et al**[39] studies showed concordant results.

PRIMARY IMPACT

The present study reveals that most victims who fall from height first hit the ground either by head/face or by trunk(side of the body) which being the site of primary impact thereby liable to death with more severe injuries. Also the site of primary impact aids in reconstructing the event of trauma.

Bharath Kumar Guntheti&Uday Pal Singh[25]study reveals that majority of falls from height the primary impact was head (around 37%). Studies by**V.Prathapan& B.Umadethan**[34]**, Vasudeva Murthy et**

al[35],**J.V.Kirankumar et al**[36]revealed that the most common site of primary impact was head/face followed by trunk.

INJURY PATTERN

HEAD INJURY

It was observed that in cases of fall from height death was due to head injury – wide range of injuries ranging from soft tissue injuries to fracture of vault, base of skull with intracranial haemorrhage was found in most cases. Subdural hematoma was the commonest intracranial haemorrhage followed by Subarachnoid haemorrhage. Extra dural Hemorrhage was also found in few cases. Comparatively base of skull fractures were more incident in falls from height than in ground level falls. Severity of head injury was proportionate with height of fall and hardness of the surface of fall (Hard soil ,concrete/cement).

Bharath Kumar Guntheti&Uday Pal Singh[25] in his study revealed that most common head injury was intracranial haemorrhage (65%) mainlySubdural hematomafollowed by Subarachnoid hemorrhage.**SteedmanDJ**[33],**V.Prathapan& B.Umadethan**[34], **C.R.Vasudevamoorthy et al**[35] shows results similar to our study.

SPINE INJURY

In the present study it was observed that most commonly cervical spine was injured, next common was lumbosacral spine injury and few cases of thoracic spine injuries. Lower cervical spine injuries owed to the primary impact on Head causing hyper extension, hyper flexion of neck due to blunt force. Upper cervical spine, thoracic spine and lumbosacral spine injuries were mainly due to primary impact on trunk/ buttock & lower limb caused by decelerated force.

Bharath Kumar Guntheti&Uday Pal Singh[25]study shows most commonly affected spine was cervical spine followed by Upper cervical spine injuries.**SteedmanDJ**[33],**V.Prathapan& B.Umadethan**[34], **C.R.Vasudevamoorthy et al**[35]studies demonstrates results similar to our study.

THORACO ABDOMINAL INJURIES

Blunt injury in fall from height leads to rib fractures, sternum fractures , lung lacerations. classical deceleration injury with Aortic laceration was absent in our study.

Common solid organ to be injured in fall from height was liver followed by spleen. Few cases of kidney injury were observed in cases were the site of primary impact was trunk.

Bharath Kumar Guntheti&Uday Pal Singh[25]study shows around 40% of fracture ribs was noted in primarytrunk impacts. 2-10 rib fractures were more common followed by sternal fractures.

SteedmanDJ[33],**V.Prathapan&B.Umadethan**[34], **C.R.Vasudevamoorthy et al**[35]studies shows results similar to our study.

Liver is the most common intra-abdominal organ involved in study by **Bharath Kumar Guntheti&Uday Pal Singh**[25]followed by spleen.

Our study results were closer to results in studies done by **V.Prathapan &B.Umadethan**, **J.V.Kirankumar et al** and **Elisabeth et al**.

BONY INJURIES

Pelvic bone fractures were observed mainly due to primary impact on buttock in victims of fall from height followed by femur fracture due to primary impact on lower limb. Fractures of upper limb bones (humerus& radius) were rarely found in the victims.

Study by demonstrates pelvic bone fractures were mainly due to buttock impact.

Steedman et al ,V.Prathapan&B.Umadethan, **J.V.Kirankumar et al**, **C.R.Vasudevamoorthy et al** studies shows similar kind of results. Fractures of femur were mainly observed in cases of primary leg impacts.

CAUSE OF DEATH

Our study revealed that the most common cause of death in fall from height victims was polytrauma followed by headinjury.

Study by **Bharath Kumar Guntheti&Uday Pal Singh**[25] exhibits Poly trauma noticed in fall from height victims on hard surfaces and isolated fatal injuries were hall mark of falls over the soft surface.

Studies by **C.R.Vasudevamoorthyet al**[35] and **Elisabeth et al**[39] disclosed concordant results with our study.

Knights forensic pathology[40] also quotes the same.

CONCULSION

Fall prevention strategies should be comprehensive and multifaceted. They should prioritize research and public health initiatives to further define the burden, explore variable risk factors and utilize effective prevention strategies.

They should support policies that create safer environments and reduce risk factors. They should promote engineering to remove the potential for falls, the training of health care providers on evidence-based prevention strategies; and the education of individuals and communities to build risk awareness.

Effective fall prevention programmes should be framed to reduce the number of people who fall, the rate of falls and the severity of injury should a fall occur. For older individuals, fall prevention programmes can include a number of components to identify and modify risk, such as:

Possible interventions should include:

Provision of safety devices such as grab handles, high friction floors and footwear, as well as low power lighting at night

- Regular exercise - lower limb strengthening exercise to increase muscle strength. Other forms of exercise, such as those involving

gait, balance, co-ordination and functional tasks, may also help improve balance in older adults.

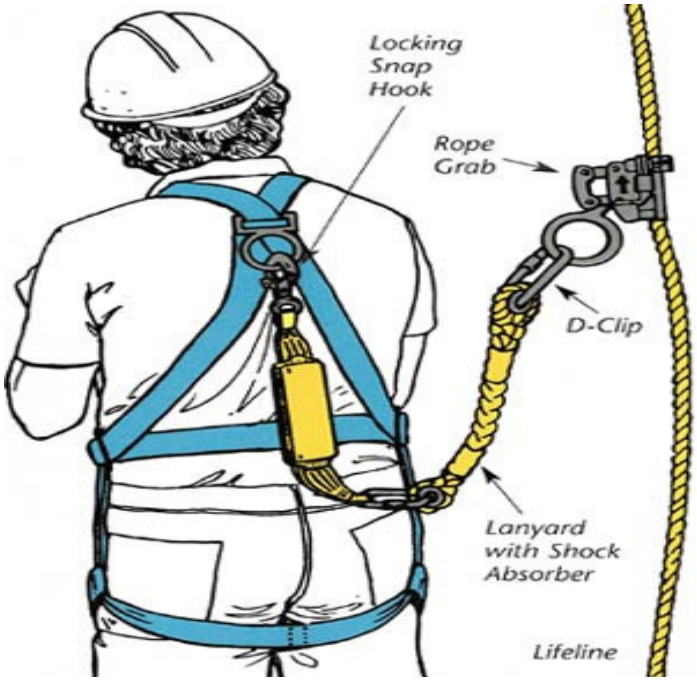
- home assessment and environmental modification for those with known risk factors or a history of falling;
- prescription of appropriate assistive devices to address physical and sensory impairments;
- muscle strengthening and balance retraining prescribed by a trained health professional;
- community-based group programmes which may incorporate fall prevention education and Tai Chi-type exercises or dynamic balance and strength training;
- Review– monitoring of medications and ongoing medical problems
- Supplementation with vitamin D, as determined by the European Food Safety Authority that vitamin D deficiency is associated with increased risk of falling and bone fractures in women and men over 60 years old; "in order to obtain the claimed effect, 800 I.U. (20 μg) of vitamin D from all sources should be consumed daily.

Hip protectors - probably decrease chance of hip fractures slightly, although it may increase the small chance of a pelvic fracture in older adults living in nursing care facilities.

- Sensitization of architects, builders and masons for safer designs of stairs,

  balconies and rooftops with appropriate railing, grab bars and landings.
- Publicizing safety standards for grills on windows.
- For children, effective interventions include multifaceted community programmes; engineering modifications of nursery furniture, playground equipment, and other products; and legislation for the use of window guards. Other promising prevention strategies include: use of guard rails/gates, home visitation programmes, mass public education campaigns, and training of individuals and communities in appropriate acute pediatric medical care should a fall occur
- Encouragement / evolution of safer working techniques and harnesses for construction workers and window cleaners who work at heights and tree

:



Prevention of fall at the construction/ work place

Above image shows how safety measures being incorporated

after a case of fall occurred at that place

Loss of human life can be prevented if safety measures like

- Self-retracting life lines (SRLs)
- Locking snap hooks
- Head gear
- Rope grab
- Life line anchor
- Lanyard and shock absorber.

SUMMARY

1) The study consisted of 210 victims of accidental falls, subjected to autopsy in mortuary of Madurai Medical College and Government Rajaji Hospital, Madurai for a period of one year between January 2016 to December 2016.

2) The incidence of accidental fall for the year 2016 was 6.16%. 54.8% of accidental falls were ground level falls and 45.2% were fall from height.

3) Among the ground level fall victims the age ranged between 4-85 years with peak incidence of 22.6% in the 61-70 year age group. 4.3% of victims in the age group < 20years with least incidence.

   - Among the fall from height victims the age ranged between 1year – 75years with maximum incidence of 24.2% in the 21 – 30years age group. Least incidence of 1% in <10years age group.

4) In Both ground level falls & falls from height there was a male preponderance.

   Sex ratio in ground level fall victims was 3.3:1

   Sex ratio in fall from height victims was 4.9:1

5) In both Ground level falls & falls from height maximum deaths were incident between12 noon – 6 pm and least cases during 12 midnight – 6 am. 40cases (34.8%) of Ground level falls & 40 cases (42 .1%) of fall from height occurred between 12 noon – 6pm.

6) Out of 115 ground level fall victims 46 cases (40%) were indoor ground level falls in bathrooms, bed/chair & floor and 42 cases(36.5%) were outdoor ground level falls in streets & balcony.

- Out of 95 fall from height victims most were outdoor falls. 32(33.7%) died due to fall in construction sites and 16 cases(16.8%) died due to fall from trees.

7)67(58.3%) out of 115 victims of Ground level fall had a fall over tiles and marbles and 28(24.3%) had fall over hard soil.

- 30(31.6%) out of 95 victims died due to fall from height on Hard soil and 25(26.3%) victims over cement & concrete.

8)24.3% Ground level Fall victims survived for less than 1 day, 59% victims survived for 1 – 10 days.

- 38.9% of Fall from height victims survived less than 1 day, 38.9% survived for 1 – 10 days and 13.68% victims were brought dead.

9) In both Ground level falls and falls from height, Head/Face was the commonest site of primary impact followed by trunk.

10) Injuries to Head and Cervical Spine were the important features of primary Head impacts. Fracture of pelvis and sacrum are the hall mark of primary buttock impact.

11) In both Ground level fall & fall from height, Head Injuries were the commonest injury; Subdural Hematoma (SDH) was the commonest lesion. Fracture Skull was more common in fall from height victims.

12) Among Visceral lesions – liver, spleen, lung lacerations were more frequent in fall from height victims than ground level fall victims.

13) Among Non-Skull fractures like Spine, Pelvis, Femur and Rib fractures were more prevalent and severe in fall from height victims.

14) Among cause of death – Head Injury was the commonest cause in Ground level fall victims (77 Cases – 67%) and Polytrauma (36 Cases – 37.9%) being the cause in fall from height victims.

15) Polytrauma was more prevalent in victims who fall from more height and who fall over Hard Surface.

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